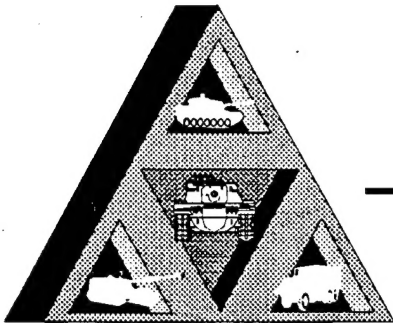


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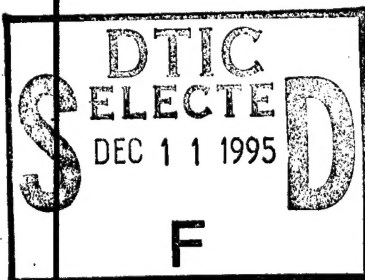
Technical Report

No. 13643

Replacement of P-D-680 Solvents for General Maintenance of DOD Equipment

Interim Report

September 1995



19951207 017

By

In-Sik Rhee
Carlos Velez
Karen Von Bernewitz

USA Tank Automotive RDE Center
Mobility Technology Center Belvoir



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Section I Background

Army and other Department of Defense facilities are experiencing problems in using P-D-680, Dry cleaning and Degreasing solvent¹, for their maintenance activities. Currently, numerous federal, state, and local regulations impact usage of P-D-680 as a hazardous waste, a flammable material, a toxic substance, and an air pollutant. For example, Environmental Protection Agency (EPA) waste disposal regulations categorize P-D-680 with a flash point less than 60 °C as a hazardous waste because it is categorized as ignitable. Department of Transportation (DOT) regulations consider P-D-680 Types I and II with minimum flash point requirements of 38 °C and 60 °C, respectively, to be flammable for domestic and international shipments. Especially, Type I of P-D-680 solvent is somewhat toxic and contains significant amounts of volatile organic contaminants (VOCs), thus is regulated by Occupational Safety and Health Administration (OSHA) and local government. This is an especially critical issue in areas such as California, where the laws are most stringent. To resolve this problem, Type III, which was added in 1992, has a 93.3 °C minimum flash point requirement and is not classified as a hazardous waste because of its higher flash point. Unfortunately, many users are not willing to use this solvent due to its weak solvency and slow drying time. However, despite its limitations, the volume of P-D-680 procured through Defense General Supply Center (DGSC) for DOD during FY 1993 was reported about 0.4 millions gallons². This indicates a large quantity of P-D-680 solvent is needed for a wide variety of general maintenance operations within DOD.

The Fuels and Lubricants Division of the Mobility Technology Center-Belvoir as DOD Executive Agent for all ground fuels and lubricants manages the P-D-680 federal specification. Because of this role, work was undertaken to consider environmentally compliant alternatives to P-D-680 which would be able to meet military requirements. A 1992-1993 work effort performed by the Fuels and Lubricants Division analyzed the usage of P-D-680 for DOD ground equipment and determined (1) the majority of P-D-680 uses are for general maintenance applications, (2) a large number and variety of commercial solvents are available, and (3) a perfect substitute to replace P-D-680 in all of its military usage could not be determined without follow-on efforts. For this reason, a program was re-initiated to determine the requirements for general purpose, environmentally compliant substitute for P-D-680. This program, funded under the DGSC's HAZMIN Program, was divided into the following two Phases.

Phase I: Conduct user survey for P-D-680 solvents and evaluate commercial alternative solvents

Phase II: Conduct field validation tests, and develop draft revision of P-D-680 specification

In Phase I, a user survey was planned to determine requirements and constraints for a general purpose cleaning solvent in order to meet military needs. Based on this information, the tentative guidelines were developed to evaluate commercial solvents and subsequently accepted. These candidate commercial solvents were tested in the laboratory to determine their conformance to the needed requirements. After successful products have been tested in the laboratory, their performances are to be verified in field tests which are planned as Phase II. If candidate solvents are acceptable, a draft specification will be written for formal coordination.

During a period of 1994-1995, all tasks of Phase I were completed and twenty-three (23) commercial solvents were identified as candidate alternative P-D-680 solvents.

This interim report summarizes the results of Phase I study and provides recommendations for Phase II task.

Section 2 P-D-680 User Survey

The objectives of P-D-680 user survey were to determine what is viewed to be requirements for P-D-680 solvents, the positive and negative aspects of current solvents, and the characteristics of an "ideal" solvent replacement. To best meet the current needs of the Army and DOD for a multipurpose cleaner, a user survey, which is attached in Appendix, was prepared and sent out to maintenance experts, program managers, environmental personnel who are currently using P-D-680 solvents in their facilities. A total fifty-four (54) responses were received from various installations operated by Army, Navy, Air Force, Marine Corps, National Guard, and NATO. Table 1 lists the P-D-680 users who participated, and their comments are summarized in Tables 2-3. Most users reported that P-D-680 solvents are excellent degreasers, have good corrosion protection properties, and are currently used for degreasing of machine parts in equipment maintenance including helicopters. Twenty-five (25) percent use Type I, sixty-three (63) percent use Type II, and twelve (12) percent use Type III. The survey also indicated that Types I and II solvents do not meet the numerous federal, state and local environmental regulations due to their high VOCs and low flash points. In conjunction with replacement of P-D-680 solvents, most users did not want to substitute other types except for petroleum based solvents in their applications due to its rusting, freezing and compatibility problems. Concerning the quality control of P-D-680 solvents, most users expressed negative responses in having a Quality Product List (QPL) for P-D-680 solvents because off-the-shelf products are more readily available. However, they want to have some quality control on P-D-680 solvents for safety. In this survey, P-D-680 users also expressed their own opinions on the requirements and constraints for an ideal P-D-680 solvent that can be used in their applications. These are summarized as follow:

- Effective clean and fast drying
- Low VOCs
- Low toxicity and low odor
- Low flammability (high flash point)
- Recyclable
- Material compatible
- Biodegradable
- Cost effective
- Corrosion protection

Section 3 R&D Plan and Evaluation Criteria for Alternative P-D-680

Based on the user survey, a new vision was established to resolve the current P-D-680 problems and to evaluate commercial candidate solvents for replacement of P-D-680. These new approaches summarized below will tend to resolve environmental problems and deficiencies, and reduce logistic burden of P-D-680 solvents.

- Type I of P-D-680 solvents will be replaced with alternative solvents. This solvent is listed as EPA Hazardous Waste Number, D001 and currently, all military services do not recommend using it in military applications due to its high flammability.
- The requirements of Type II solvent will be revised to increase its flash point (minimum 62 °C) and to reduce toxic volatile organic compounds (VOCs) levels to meet emission regulations, and local/federal environmental regulations. This solvent is listed as a primary solvent in military applications.
- Type III solvent is currently considered as a safe cleaner among military solvents. However, the solvency of Type III should be improved and its availability must be increased.
- All Types of P-D-680 solvents to have reduced toxicity and odor.
- All solvents must provide strong solvency and corrosion protection.
- All solvents must be recyclable to reduce hazardous waste.
- All solvents should be inexpensive and widely available.
- Other types of solvents meeting these guidelines will be considered as substitute solvents.

To assess P-D-680 alternative solvents, a test plan was developed based on the requirements of P-D-680 specification and user inputs obtained from the survey. Typical tests performed on all samples were flash point, distillation (initial boiling point, drying point), Kauri-Butanol value, Aniline point, odor, recyclability, VOC, evaporation, non-volatile residue, corrosion protection, and relative solvency. Environmental tests (air pollution, biodegradability, toxicity) were not included under this testing program due to the unavailability of test equipment. The test protocol is listed in Table 4.

Section 4 Market Survey for Alternative Solvents

Cleaning is an essential process in the production, maintenance, and repair of equipment. As a surface preparation process, most cleaning applications require removal of oil, grease or carbon deposits which form sticky masses of hydrocarbons embedded deeply in the pores of any surface, metal, rubber, ceramic, vinyl, fabric, carpet or concrete. Currently, numerous different types of cleaners/solvents are formulated for use in various of applications and are available in domestic markets. Table 5 lists P-D-680 alternative solvents that are commercially available for metal component cleaning. These solvents/cleaners can be divided in four main groups: aqueous, semi-aqueous, hydrocarbon solvent, and terpene based. Aqueous cleaners basically use water or exotic combinations of water, detergents, saponifiers, surfactants, corrosion inhibitors and other special additives, as the primary solvent. Alcohol, alkaline, surfactant, enzyme, etc. also belong to this solvent classification. These types of solvents have virtually no VOCs and do not significantly generate hazardous waste. However, their cleaning efficiencies, soil retention, and corrosion protection are very weak for heavy duty tasks.

Semi-aqueous cleaner is an organic solvent blended with water. The performance of this cleaner is generally better than that of aqueous cleaner. However, this cleaner must be removed from the cleaned component with water. In addition, its waste water must be removed prior to disposal of the used cleaner. This could make the usage of this cleaner less economically viable.

Hydrocarbon solvents used for parts and equipment cleaning are derived from petroleum or renewable sources. The petroleum based hydrocarbon can be divided into two main groups (aliphatic and aromatic hydrocarbons) in different ways based on chemical compositions. Aliphatic hydrocarbon solvents are currently marketed as naphtha, mineral spirits, stoddard solvent, kerosene. These solvents have straight chain of carbon atoms and are a range of compounds with 6 to 15 carbons. Naphtha is used in thinning paints and varnishes and frequently employed in lacquers. Mineral spirits are also used as thinner and solvent in paint and varnish industry, and extensively used as metal cleaner such as P-D-680 Types II and III. In a similar application, stoddard solvent such as P-D-680 Type I is used frequently in the dry cleaning industry and metal cleaning. Kerosene is also used as a metal degreaser. Aromatic hydrocarbon solvent is often called "Benzene Ring Hydrocarbon Solvent" and cover benzene, toluene, xylene etc. These

solvents are currently defined as hazardous materials due to their toxicity. However, their solvency are stronger than those of aliphatic hydrocarbon solvents.

Terpenes are a class of organic compounds extracted from plants such as the bark of pine trees or citrus fruit skins³. They have been used in household cleaners, pharmaceuticals, deodorizers, and metal cleaners. These products have long been used as highly effective solvents for a variety of organic compounds, including greases and oils. In addition, they are also extensively used in the fragrance and flavoring markets because of their low toxicity and fragrant aroma. There are over several hundred known terpene molecules creating a large base of possible combinations, and because of this, most terpene solvents do not have the same types of characteristics and are available in extremely large quantities. Terpene solvents are one of the few environmentally acceptable alternatives to traditional petroleum based solvents. They are classified as non-toxic, non-carcinogenic, non-hazardous, non-ozone depleting and completely biodegradable. They can be recycled through distillation and, when disposal is necessary, they can also be incinerated because of their high BTU value and clean burning characteristics. Currently, these solvents are used in pure form or with water, or blend with petroleum based hydrocarbons.

Section 5 Test Results

Eighty-two (82) samples were received from forty (40) oil companies which were listed in Table 5. These samples were originally solicited for evaluation as potential substitutes of P-D-680 solvents. Most solvents are currently used for general maintenance parts cleaning and were formulated with various chemical materials classified as aqueous, semi-aqueous, terpene and petroleum. To assess their physical and chemical properties, all samples were tested according to an established testing protocol. Some aqueous and semi-aqueous solvents were diluted with water, according to the manufacture recommendations, prior to the test. To provide baseline comparison data, P-D-680 solvents were also evaluated. Table 6 summarizes the results of tests which were conducted through in-house laboratory testing which included a relative solvency test. Code letters have been used in Tables 5 and 6 to represent the identities of the samples submitted.

The degree of flammability of solvents is generally determined by flash point measurements. Flash point is currently defined as the lowest temperature at which the vapor at the surface of solvent will ignite. The most common method of determining flash point is the ASTM D 56 test method for Flash Point by Tag Closed Tester which confines the vapor until the instant the flame is applied. P-D-680 specification requires three minimum flash point values (Type I: 38 °C, Type II: 60 °C, Type III: 93.3 °C) for each type of solvent. The results of testing revealed that most solvents except for terpenes have a high flash point which exceeds the Resource Conservation and Recovery Act (RCRA) hazardous limit of 60 °C. Currently, solvents with flash points below 60 °C are considered as RCRA hazardous material. Aqueous and semi-aqueous types of solvents did not show any flash point due to the water being present. In general, most chlorinated and fluorinated solvents have no flash point. However, these types of materials are currently considered as ozone depleting chemicals.

The solvent power of a hydrocarbon is measured by several different tests, each of which is primarily applicable to certain product uses. One of these tests is for Kauri-butanol (KB) value, which is an expression showing the relative tolerance of Kauri Gum dissolved in butyl alcohol. A high KB value usually indicates a strong solvency of certain solvents. The test results showed that the test method is only applicable to the petroleum based solvents such as P-D-680 and their KB values were obtained ranging from 24 to 71. These KB values are much lower than those of aromatic solvents such as toluene (KB: 105). An aniline point, which defines the temperature at which equal volume of solvent and aniline are mutually soluble, is another

way to express the solvent power of hydrocarbon solvents and is most often used to provide an estimate of the aromatic hydrocarbon content of solvents. This value usually indicates a reversal of solvent power when applied to solvents that are same range of KB value. To verify the KB values obtained from hydrocarbon samples, aniline point tests were also conducted using ASTM D 611 test method. The test results agreed with KB values obtained. However, both test methods were not applicable to measure the solvency of other than hydrocarbon solvents (e.g., aqueous and semi-aqueous solvents, terpene based solvents). To assess the solvency for all types of solvents, a simple soil test procedure was developed using a ultrasonic cleaner. The soil utilized in this test was a military multipurpose grease, MIL-G-10924, Grease, Automotive and Artillery⁴, which is currently used on more than eighty (80) percent of ground equipment and vehicles. The solvency was rated from zero to hundred (100) percent in this test. The soil test results showed that the test method developed was adequate to determine the solvency of all types of solvents. In this test, P-D-680 solvents provided excellent solvency among the tested samples, while alkaline based solvents did not effectively remove grease soil as expected. Especially, P-D-680 Type II showed an equivalent solvent power when compare with P-D-680 Type I.

Drying time is currently considered as an important operational parameter in a part cleaning process. A solvent with low flash point such as P-D-680 Type I tends to have low heats of vaporization and high pressures, and allow evaporative drying of cleaned parts. On the other hand, this type of solvent dries fast but is an air pollutant and a health hazardous substance. Regardless its environmental problem, a fast drying solvent is still required to clean the certain critical military systems such as electronic components used in missile applications. In general, the volatility of solvent governs evaporation rate or drying time. This property is usually determined by the distillation drying temperature or range of temperatures of the solvent. Table 5 revealed solvents having a low flash point provide lower drying temperatures when compared with the high flash point solvents. To verify these results, evaporation tests were conducted using Thermogravimetric Analysis (TGA). To simulate field cleaning conditions, the test was performed at 40 °C, for 20 minutes. This testing time was assumed to represent fast drying time expected in the field. The evaporation test results agreed with drying points obtained from the distillation tests. Both tests clearly indicated that the drying capability of solvent closely correlates to its flash point. For this reason, we did not find any solvent having both high flash point and fast drying properties in this evaluation.

Corrosion protection characteristics of alternative solvent is another important parameter to accept it in the military applications. P-D-680 solvents are currently used for general maintenance parts cleaning and provide an excellent corrosion protection on the surface of metal parts. This property is essentially required in military part cleaning applications. To assess the corrosion properties of alternative solvents to P-D-680, copper corrosion tests were performed according to the ASTM D 130 method. The results showed that most water based solvents produced severe corrosion problems, while the petroleum based solvents such as P-D-680 gave excellent corrosion protection. Also, terpene/hydrocarbon blended products provided the same degree of corrosion protection observed for petroleum based solvents. To provide more evidence, a steel corrosion test was conducted using the modified ASTM D 130 method. These test results gave a good agreement with data obtained from copper corrosion tests.

The release of volatile organic compounds (VOCs) into the atmosphere is being more tightly regulated to reduce air pollution in U.S.A. At present, many states have some form of VOC control regulation, either state wide or on a county or local basis. In metal cleaning, the amount of VOC content in solvent depends on the chemical composition and volatility of the cleaning agent. Currently, many local governments exempt solvents from VOC regulations if the vapor pressure, which gives a correlation with the evaporation rate, is below a certain limit, typically 0.1-20 mm Hg at standard conditions (20 °C). P-D-680 solvents are defined as photochemically non-reactive by California South Coast Air Quality District Rule 102, and non-ozone depleting chemical material, while some states defines P-D-680 Type I solvent as a hazardous material due to its high volatility. For instance, the South Air Quality Management District (SCAQMD) Rule 1171 allows maximum VOC emissions of 900 g/l or 20 mm Hg for repair and maintenance cleaning⁵. Based on these limits, most solvent samples evaluated met these requirements. As expected, water based solvents contained very small amount of VOCs due to the water being present.

The odor of a solvent generally refers to the odor of vapor during and shortly following applications. Occasionally, there may be a persistent residual odor contributed by trace contaminations. Especially, the odor is most critical in enclosed spaces such as a small room. Table 6 provides the characteristics of odor obtained from the samples. The typical aliphatic solvents such as P-D-680 Types I and II have a very strong odor, and because of this, they often provide unpleasant working environments. To date, the numerous "deodorants" promoted for use in the unpleasant solvents and the various

types of odorless solvents are commercially available. P-D-680 specification also controls this characteristics and provides an odorless product as Type III. This type of solvent usually provides a low cleaning efficiency when compared with regular one.

Solvents are currently considered as a total volatile material. However, some non-volatile residue are often found on the cleaned surface of parts or equipment in military applications. Generally, the impurity of the solvent significantly affects to the effectiveness of cleaning and is a strictly quality control problem rather than its formulation problem. To determine the solid composition of alternative solvents, a TGA method was adopted in this study⁶. This method was originally developed to measure volatility of lubricants/solvents and residue. In this TGA analysis, only base stock and soluble additives of solvent evaporate through a wide temperature range (up to 400 °C), while the insoluble materials remain as residue of the sample. This method tends to more effectively determine the non-volatile residue property of solvents in a short time period than the ASTM D 1353 method specified in P-D-680 specification. Only hydrocarbon solvents including their blends were tested and their results are reported in Table 6. Most solvents tested provide almost no residue.

Solvent recycling is common practice in many industries and wide range of solvents are currently recycled using several different types of distillation techniques (i.e., azeotropic distillation, packaged solvent and vacuum distillation). During P-D-680 user survey that was recently conducted within DOD, most military users expressed their concerns to the current disposal problems of P-D-680 solvents. For this reason, P-D-680 recycling potentially reduces waste stream and is a first step among many to resolve the environmental problems that the military currently faces. To determine recycling capability of alternative solvents, distillation tests were conducted using ASTM D 86 method. The test results showed that a few terpene based solvents produced severe degradation problems after distillation due to their poor thermal stabilities or complexity of chemical structure. Such a solvent cannot be recycled and will create a heavy wastestream. Petroleum hydrocarbon based solvents such as P-D-680 solvents did not have any recycling problems. Currently, P-D-680 solvents are being disposed through fuel blending.

Section 6 Conclusions/Recommendations

On the basis of the work completed to date, it was found only petroleum distilled hydrocarbon solvents and terpene/hydrocarbon solvents meet current P-D-680 performance requirements which reflect military needs. Especially, terpene/hydrocarbon blended solvents showed excellent performance in all requirements. However, these products never have been used in military applications. Therefore, the adoption of these terpene/hydrocarbon blend solvents as a new Type IV P-D-680 solvent is highly recommended because of their potential to replace Types I and II under P-D-680. Unlike these solvents, aqueous types of solvents and water based solvents do not lend themselves as candidate P-D-680 solvents due to their poor corrosion protection and solvency.

Based on our limited test results, a twenty-three (23) commercial solvents was found for candidate alternative P-D-680 solvents. These products provide excellent solvency, are currently listed as less hazardous solvents, and meet the federal and local environmental laws (i.e., RCRA). In addition, all candidate solvents have recycle capabilities which can be reduce wastestream. Unfortunately, the replacement of P-D-680 Type I solvent was not found in commercial market because its fast drying characteristics. However, P-D-680 Type II solvents can be used as alternative Type I because of their similar performance. The following Table lists the candidate solvents which were found in Phase I study.

Type	Solvent composition	Flash point	Candidate solvents
I	Hydrocarbon	>38 °C	Type II solvents
II	Hydrocarbon	>62 °C	Breakthrough Brulin MP 1793 Daraclean 291XX D-Greeze 500 Envirosolv 655 EZE 662 Shell 142 Ht Unocal 150 Actrel 1171L Formula 724
III	Hydrocarbon	>94 °C	Parimaclean 3600 134 Hi-Solv

IV	Terpene/Hydrocarbon Blend	>62 °C	Envirosovl 652 Re-entry KNI 2000 Re-entry KNI 1200 De-solv-it HD De-solv-it IF Voltz Electron 296 PF Skysol skysol 100 Quaker 68 RAH
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Because of these candidate P-D-680 solvents have never been used in military applications, it is recommended that their performance must be validated in a field test which is planned in Phase II of this program.

TABLE 1. P-D-680, USER INFORMATION

Code	Organization	Address	POC	Application
S-1	Tobyhanna Army Depot	Department of Army Tobyhanna Army Depot 11 Midway Road Tobyhanna, PA 18466-5086	Mr. Michael L. Parrent DSN: 795-6105	Tactical vehicles, combat service support (communications-electronics, power systems)
S-2	Crane Army Ammunition Activity	Department of Army Crane Army Ammunition Activity Attn SMCCN-EDS 300 Highway 361 Crane, IN 47522-5099	Mr. Norman Thomas DSN: 482-1439	Ammunition items
S-3	National Guard of Nebraska	National Guard of Nebraska USPFO for Nebraska 1111 Military Road Lincoln, NE 68508-1093	SFC Loren Saathoff DSN: 946-1182	Surface Equipment (e.i., fuel tanks, immersion heaters)
S-4	501st Corps Support Group	Department of Army DEH, Area 1 East (Camp Page) ATTN EANC-YG-CP-DEH Unit #15002 APO AP 96208-0210	Mr. C.A. Johnson DSN: 721-5447	Tactical Vehicles and Equipment, Generators
S-5	Army National Guard of Arkansas	Department of Army Army National Guard of Arkansas ATTN DM-SES North Little Rock, AR 72118-2200	Maj. Ronald E. Stanley DSN: 731-5764	Repair parts from tactical/combat vehicles and small arms weapons parts
S-6	Nebraska Air National Guard	USAF, Nebraska Air National Guard 155th Air Refueling Group 2420 West Butler Ave. Lincoln, NE 68524-1897	SMS. Richard A. Frerichs DSN: 946-1366	Fixed wing aircraft (air refueling, vehicle maintenance, aircraft support equipment, aircraft engine maintenance)
S-7	Army National Guard of Pennsylvania	Department of Military Affairs State Surface Maintenance Office Bldg 9-68, Fort Indiantown Gap Annville, PA 17003-5002	CW3 Lynn Deaven DSN: 491-8616	Parts for Tactical vehicle parts, Engineer equipment, Armored vehicles

Table 1 (continued)

Code	Organization	Address	POC	Application
S-8	Army Engineering Center at Fort Leonard Wood	Department of Army U.S. Army Engineering Center and Fort Leonard Wood ATTN ATZT-DL-M Fort Leonard Wood, MO 65473-5000	Mr. Ken Buckingham DSN: 581-0617	All classes of materials except medical equipment
S-9	New Jersey Air National Guard	New Jersey Air National Guard 108th ARW/LGQ 33-22 Flebelkorn Road McGuire AFB, NJ 08641-5406	MSG Rutledge E. Miller DSN: 440-6887	Aircraft equipment, Reciprocating engines, Jet engine anti-friction bearings and power turbines
S-10	Fort Sam Houston Maintenance Division	Department of Army Ft. Sam Houston AFZG-DL-MO 2107 17th Street Fort Sam Houston, TX 78234-5036	Mr. Jerry Rogers DSN: 471-9850	Weapons, artillery, tactical vehicles, commercial and tactical MHE and components
S-11	Alaska Army National Guard Surface Maintenance Manager's Office	Department of the Army Alaska Army National Guard ATTN AKNG-ARL-SMM P.O. Box 5800, Fort Richardson, Alaska 99505-5800	MAJ. Stephan Dewan DSN: 317-384-4440	Weapons, Tactical and Combat Vehicles
S-12	4th Special Operations Support Command	Department of the Army 4th Special Operations Support Command ATTN AP8O Fort Shafter, Hawaii 96858-5435	CPT. Karl R. Seabaugh DSN: 315-439-6745	Weapons and limited support equipment
S-13	South Dakota Army National Guard	The South Dakota Army National Guard ATTN SDCLO 2823 West Main Street Rapid City, South Dakota 57702-8186	LTC Burton L. Sly DSN: 747-8775	Aviation
S-14	Bradley Air National Guard	103 Cam Squadron Bradley Air National Guard Base 100 Nicholson Road East Granby, CT 06026-5000	Mr. Howard W. Fitzpatrick DSN: 297-2304	Aircraft and relaxed parts, aluminum alloys

Table 1 (continued)

Code	Organization	Address	POC	Application
S-15	Rock Island Arsenal (RIA)	U.S. Army Munitions and Chemical Command ATTN SMCRI-QAM-S Rock Island, IL 61299-6000	Mr. Tom Maehr Tel) 309-782-1568	Fixtures for weapon manufacturing
S-16	Rock Island Arsenal (RIA)	U.S. Army Munitions and Chemical Command ATTN SMCRI-DLD Rock Island, IL 61299-6000	Mr. Don Cram Tel) 309-782-5190	Tool Sets
S-17	West Virginia Air National Guard	Department of the Air Force 167 MAS/MAFG EWWRA-Shepherd Field Martinsburg, WV 25401-7704	Mr. Kenneth Clohan Tel) 304-267-5095	Parts on Aerospace Ground Equipment
S-18	Kentucky Army National Guard Boon National Guard Center	Department of the Army Boon National Guard Center ATTN KG-DOM 100 Minuteman Parkway Frankfort, KY 40601-6168	Mr. Martin R. Dunaway Tel) 502-564-6362	Artillery mechanism and mortars, Components of combat vehicles, tactical vehicles
S-19	Nebraska Army National Guard	Nebraska Army National Guard Aviation Support Facility Bldg 624 LMAP Lincoln, NE 68524-1898	CW3 Lyle McKlem DSN: 946-1475	Rotary wing aircraft UH-1, OH-58 and Cobra
S-20	Mississippi National Guard	Mississippi Army and Air Force National Guard Maintenance Shop MATES, Bldg. 6800 Camp Shelby, MS 39407-5500	Mr. Reggie D. Farve DSN: 921-2721	Weapon, artillery, armored and tactical vehicles, combat service support, parts, engines, tools
S-21	Mississippi National Guard	State of Mississippi Military Department Combined Support Maintenance Shop #1 Camp Shelby, Mississippi 39407-5500	MAJ. James I. Pylant DSN: 921-2727	Repair parts and small arms

Table 1 (continued)

Code	Organization	Address	POC	Application
S-22	10th Division Support Command	Department of the Army HQ 10th Forward Support Battalion 10th Mountain Division (LI) Fort Drum, NY 13602	CPT. Kelly A. Mecca DSN: 341-6450	Artillery, tactical vehicle repair parts
S-23	10th Division Support Command	Department of the Army HQ E CO 25th Aviation 10th Mountain Division (LI) Fort Drum, NY 13602	SGT Head DSN: 341-4495	Tactical vehicle parts/aircraft parts
S-24	10th Division Support Command	Department of the Army HQ B CO MSB 10th Mountain Division (LI) Fort Drum, NY 13602	CW2 L. Phipps DSN: 341-4284	Weapons, artillery, tactical vehicle parts and tools
S-25	San Antonio Air Logistics Center	Department of the Air Force San Antonio Air Logistics Center SA-ALC/TIESM 450 Quentin Roosevelt Road Kelly AFB, TX 78241	Mr. Brian Ballew DSN: 945-8745	Aircraft, engines, flight line support equipment
S-26	Fort Richardson, Alaska	Department of the Army HQ U.S. Army Alaska 600 Richardson Drive # 5000 Fort Richardson, Alaska 99505-5000	Mr. Penyak DSN: 384-2423	Small arms, artillery, tactical and commercial vehicles, construction equipment, material handling equipment
S-27	Marine Corps Logistics Bases, Albany	United States Marine Corps Repair Division Code 883 Marine Corps Logistics Bases Albany, GA 31704-5000	Mr. Lamar Petties Tel) 912-439-6826	Weapons, artillery, armored, tactical vehicles
S-28	Marine Corps Logistics Bases, Barstow	United States Marine Corps Marine Corps Logistics Bases Multi-Commodity Maintenance Center Repair Division (B880) Barstow, CA 92311-5015	Mr. Richard A. Mstrel DSN: 282-7136	Tactical vehicles, radiator
S-29	Oregon Air National Guard Fighter Maintenance Squadron	142 MAS/Oregon Air National Guard 6801 N.E. Cornfoot Ave. Portland, OR 97218-2797	Mr. Brian K. Kohl DSN: 638-4326	Aircraft Hydraulic Systems

Table 1 (continued)

Code	Organization	Address	POC	Application
S-30	Oregon Air National Guard Repair & Reclamation Shop	142 MAS ANG Repair & Reclamation Shop 6801 NE Cornfoot RD Portland, OR 97218	Mr. CY Smith DSN: 638-4339	Aircraft Wheel Assemblies, wheel bolts and wheel attachment hardware
S-31	Oregon Air National Guard Age Section	142 MAS SQ/MAFAG Age Section 6801 N.E. Cornfoot RD Portland, OR 97218-2797	Mr. Donald R. Kutcher DSN: 638-4239	Aircraft parts
S-32	Oregon Air National Guard Weapons Release/Gun Services	142 MS/MAWR Weapons Release NCOIC 6801 N.E. Cornfoot RD Portland, OR 97218-2797	Mr. Jay H. Becker III DSN:	Aircraft ejector bomb racks, ejector missile launchers, M61A1 20mm aircraft cannon and ammo handling systems
S-33	New Hampshire National Guard	Department of the Army and Air Force National Guard Bureau U.S.Prop. & Fiscal Off. for New Hampshire P.O. Box 2003 Concord, NH 03202-2003	SFC Smith DSN: 684-9289	Aircraft parts
S-34	Puget Sound Naval Shipyard	Puget Sound Naval Shipyard C/248.4 1400 Farragut Avenue Bremerton, Washington 98314-5001	Mr. Keith Shroyer DSN: 439-6909	Naval Ship/Submarine components, shoreside support vehicles and equipment
S-35	Iowa National Guard EMC-C General Support Training Center	Iowa National Guard EMC-C Camp Dodge 7700 NW Boaver Dr. Johnson, IA 50131-1902	CW3 Jeffery S. McIntyle Tel) 515-252-4632	Components of combat service support
S-36	Iowa National Guard GS maintenance Co.	Iowa National Guard GS maintenance Co. 7700 NW Boaver Dr. Johnson, IA 50131-1902	Mr. Gerald D. Davis DSN: 946-2071	Vehicle components

Table 1 (continued)

Code	Organization	Address	POC	Application
S-37	Fort Knox, Kentucky	TRADOC G4/DOL Maintenance Division ATTN ATZK-DLM Fort Knox, Kentucky	SFC Bryan DSN: 624-4625	Weapons, Armored, Tactical vehicles, Combat service support
S-38	Fort Knox, Kentucky	TRADOC DS/G5 Maintenance Division ATTN ATZK-DLM Fort Knox, Kentucky	Mr. Harold G. Ham DSN: 624-4625	Weapons, Armored, Artillery, Tactical vehicles, Combat service support
S-39	Army Aviation Troop Command Maintenance Engineering Division	HQ, U.S. Army Aviation & Troop Command Maintenance Directorate ATTN AMSAT-I-MEP 4300 Goodfellow Blvd. St. Louis, MO 63120-1798	Mr. Stephen Schick DSN: 693-5427	Helicopter maintenance and repair
S-40	Riverbank Army Ammunition Plant	Riverbank Army Ammunition Plant 5300 Claus Road Riverbank, CA 95367	Mr. James B. Gansel DSN: 466-4100	Ammunition
S-41	149th fighter group for F16 A/B Jet Aircraft Kelly AFB	149th FG/MAF/P 108 Hensley St. Kelly AFB, TX 78247-5543	Mr. Frank G. Arbizu DSN: 969-5440	F100/200 turbo fan engine parts
S-42	Pennsylvania Army National Guard Army Aviation Support Facility	Pennsylvania Army National Guard Army Aviation Support Facility 125 Goodridge Lane Washington, PA 15301-0020	CW4 John B. Shultz	Aircraft Repair parts
S-43	Delaware Army National Guard Maintenance Shop 5	Organization Maintenance Shop (#5) Delaware Army National Guard RD 2 Box 214C Dagsboro, Delaware 19939-98021	Mr. Paul W. Baker, Jr DSN: 440-7456/7462	External parts and/or small items
S-44	Washington Army National Guard	State of Washington Military Department Camp Murray, Tacoma, Washington 98430-5000	Mr. Woc Doug Dosland DSN: 323-8944	General parts

Table 1 (continued)

Code	Organization	Address	POC	Application
S-45	Fleet Activities, Chinhae	Fleet Activities, Chinhae PSC 479 FPO-AP 96269-1100	Mr. Donald Henderson DSN: 762-5278	Electro-mechanical equipment
S-46	Wisconsin Army National Guard	State of Wisconsin Department of Military Affairs ATTN WIAR-F P.O. Box 14587 Madison, WI 53714-0587	Ms. Kerry Nicholls DSN: 724-3359	Parts of wheeled and tracked vehicles and rotary-winged aircraft
S-47	South Dakota Air National Guard	114FG LGQ 1201 W Algonquin St. P.O. Box 5044 Sioux Falls, SD 57117-5044	MSGT Kevin Kreulen DSN: 939-7813	Engine parts, guns, fuel and powered age equipment
S-48	Massachusetts Air National Guard	104th Fighter Group Massachusetts Air National Guard Barnes Municipal Airport Westfield, MA 01085-1385	SMSGT Thomas H. Sanville DSN: 636-9368	Aircraft engine parts
S-49	167th Airlift Group	Department of the Air Force HQ, 167th Airlift Group EWRRA-Shepherd Field Martinsburg, West Virginia, 25401	SMSgt David T. Park Jr. DSN: 242-9145	Aircraft engines and propellers
S-50	22nd Combat Equipment Company Netherlands	Ministerie van Defensie 22nd Combat Equipment Company POMS site EYGELSHOVEN P.O. Box 128 6470 EC, EYGELSHOVEN, THE Netherlands	Mr. Jos Van Heeswijk Tel) +31 45 35 35 35	Weapons
S-51	Arizona Army National Guard	Department of Emergency and Military Affairs Facilities Management Office 5636 East McDowell Road Building 331 Phoenix, Arizona 85008-3495	CPT Elizabeth Gilman DSN: 853-2665	Artillery and Helicopters

Table 1 (continued)

Code	Organization	Address	POC	Application
S-52	Arkansas Air National Guard	Arkansas Air National Guard 189 AG/MAFA 4600 Vandenberg Boulevard Little Rock AFB, AR 72099-5065	Mr. Hugh P. Williams	Aircraft Accessory
S-53	Montana Army National Guard	Montana Army National Guard Direct Support Combined Support Maintenance Shop P.O. Box 4789 Helena, MT 59604-4789	Mr. David Smith DSN: 747-3150	Small arms, weapons, mortars
S-54	127th F.W Shefringe ANGB	127th F.W Selfridge ANGB MT. Clemens, MI 48045	Mr. David Nowicki	Tire

TABLE 2. EVALUATION OF P-D-680 SOLVENTS

Code	Use	Advantages	Disadvantages	Corrosion Problem
S-1	Type I and II	Good oil and grease removal No rinsing with water Fast drying	Strong odor Hazardous waste High flammability Toxicity	None
S-2	Type I	Clean quickly and efficiently for parts	Strong odor Hazardous waste High flammability Toxicity	None
S-3	Type I	Cuts carbon well Dry quickly Prevent corrosion and rust	Cost of disposal Skin irritation High flammability Toxicity	None
S-4	Type II	Suitable for job	Disposal problem	None
S-5	Type II	Meet cleaning requirement Potential good recyclable product	Recycling problem due to the failure of distilling machine	None
S-6	Type II and III (Safety Kleen)	Excellent cleaner/degreaser Non-corrosive Solvent Recyclable	Strong Odor Disposal problem (contact out) High flammability Toxicity	None
S-7	Type II	Very good cleaner Remove dirt/grease and dry quickly	Strong odor Skin rashes and dryness High flammability	None
S-8	Type I, II, III (supplied by Safety-Kleen)	Satisfactory	Disposal problem Smell, fumes, volatility, dermal reaction Strong odor Toxicity	None
S-9	Commercial equivalent of P-D-680 (Safety Kleen)	Satisfactory	Hazardous material Adverse reactions to worker's health	None

Table 2 (continued)

Code	Use	Advantages	Disadvantages	Corrosion Problem
S-10	Type I	Excellent oil/grease cutter Quickly drying characteristics	Adverse effects to health (rashes, dry, cracking skin, etc...) Cost of disposal	Parts will rust if not properly treated after being washed with P-D-680 solvent
S-11	Type II, Orange-Sol product	Satisfactory	Waste disposal problem React to skin	None
S-12	Type I and III	Satisfactory	Strong odor Skin reaction High flammability Toxicity	None
S-13	Type II (Safety Kleen solvent)	Good degreaser	Disposal problem	None
S-14	Type II	Good grease cutting and air drying	Toxicity	None
S-15	Type I	Satisfactory	Dry the skin	None
S-16	Type I	Satisfactory	Skin rashes, dry skin and a very annoying order Toxicity Strong odor	White rust on parts
S-17	Commercial equivalent of Type II (Safety Kleen, F140)	Satisfactory	No comment	None
S-18	Currently not use P-D-680 Use Safety Kleen solvents	Excellent cleaning quality	Irritate skin	None
S-19	Type II	Excellent cleaner for carbon and oils	Dry irritated skin High flammability	None
S-20	Type II	Excellent cleaner	Irritated skin Strong odor High flammability Environmental hazards	None
S-21	Type II	Excellent cleaner for repair parts and small arms	Disposal problem	None

Table 2 (continued)

Code	Use	Advantages	Disadvantages	Corrosion Problem
S-22	Unknown	Excellent cleaner	Slow drying time Bleaching of parts Skin rashes and dry skin problem	None
S-23	Type I	Good cleaning agent for parts	None	None
S-24	Type II	Quickly removes carbons	None	None
S-25	Type II and III	Satisfactory in Type II	Type III is not suitable for all purpose due to the residue or lack of cutting power Strong odor in Type II	None
S-26	Type II Jet Pressure Wash with hot water and detergent	Satisfactory	Environmental problem	None
S-27	Type II (past) Sparkle cleaning vats	Do not use	Hazardous waste disposal	None
S-28	Type II	Good cleaner	Environmental problem	None
S-29	Type II	Good degreaser	Leave an unwanted film residue	None
S-30	Type II	Excellent cleaner	Health hazards including nausea, dizziness, minor skin irritations Cost of disposal	None
S-31	Type II	Good degreaser	Disposal problem (use a solvent recycler)	None
S-32	Type I	Excellent cleaner	No problems when using wearing groves, apron, face shields under adequate vents or air circulation	None
S-33	Type II	Satisfactory	None	None

Table 2 (continued)

Code	Use	Advantages	Disadvantages	Corrosion Problem
S-34	Type I and II (supplied by Safety-Kleen)	Excellent cleaner	Strong odor	None
S-35		Good cleaner	Difficult clean oil and grease sludge	None
S-36	Safety-Kleen Solvents	Good cleaner	None	None
S-37	Type II (under contract)	Good degreaser	Skin irritation	None
S-38	Type II (under contract)	Good cleaner	None	None
S-39	Type II Maintenance Engineering Division	Good degreaser	None	None
S-40	Type II	Good degreaser	Health/safety problem (i.e., nausea and light headache)	None
S-41	Type III	Good cleaner	Waste disposal Health concern	None
S-42	Type II (Safety - Kleen Solvent)	Good cleaner	None (under contract)	None
S-43	Simple Gleen Hot water	No comment	Health problem	None
S-44	Type II	Good cleaner Recyclable	No comment	No comment
S-45	Type II	Effective cleaner	None	None
S-46	Type I (past used)	Satisfactory	Hazardous waste Safety concern Voc problem	None
S-47	Type II	Satisfactory	Disposal problem	None
S-48	Type III	Satisfactory	Disposal cost Safety for personnel and the environment	None

Table 2 (continued)

Code	Use	Advantages	Disadvantages	Corrosion Problem
S-49	Type II (under contract)	Satisfactory	Health problem	None
S-50	Type I	Satisfactory	Breakdown of commercial steam cleaners by clogged up lines with use of P-D-680	None
S-51	Type II	Satisfactory	None (contract)	None
S-52	Type II	Satisfactory	Hazardous waste	None
S-53	Type I	Satisfactory	Environmental problem	None
S-54	Type I	Good cleaner	Hazardous waste	None

TABLE 3. REQUIREMENTS OF THE IDEAL P-D-680 SOLVENT

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-1	Effectively clean Non-hazardous Fast drying Easily recyclable Low toxicity Low flammability (flash point > 140 F) Low odor	Room temperature (73 F)	Create corrosion problem Water entrapment Residue Leaching heavy metals (cadmium)	Elastomer, paint, solid lubricants, electronic components, circuit boards, wiring, connectors	Yes
S-2	Effectively clean Non-toxic Environmentally acceptable No residue Low flammability	50 F - 100 F	Acceptable if solvent removes tar efficiently, quickly, and without any residue	Explosives	No
S-3	Environmentally friendly Nonflammable Works well without heat Works quickly Dries quickly Leaves no residue Requires minimal brushing to clean Nontoxic No skin irritating	- 30 F	Acceptable for ground maintenance shops because everything is normally blown dry with compressed air	Plastic, rubber, and silicone sealers	No
S-4	Multipurpose cleaner High flash point Ease of Disposing Biodegradable	Indoor temperature	Acceptable to resolve disposal problem	Paint, elastomer, lubricants	Either way
S-5	High flash point Recyclable Low odor for identification Low toxicity	Indoor temperature	No comment	No comment	Yes

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-6	Effectiveness Non-hazardous to environment and health Non-corrosive Ease of disposing Recyclable Economically affordable High flash point Low odor Low toxicity	0 F	Not acceptable because 1)do not remove all foreign matter without lots of manual labor, 2)can not be toughly rinsed and dried , 3) causes corrosion	Paints, solid film lubricants, rubber seals	Yes (preferred)
S-7	Easy to use and non-harmful to personnel Remove grease and carbon High flash point Low odor	- 20 F	Not acceptable because of freezing and rust problems	Lubricants	Yes
S-8	Biodegradable Water soluble No dermal reaction Ease of disposing Nonflammable Non-volatile Safe for contact with skin	No comment	No comment	Rubber, plastic, paints	No
S-9	Grease cutting Water soluble Minimal health hazard High flash point Disposal much easier	20 F - 150 F	Acceptable	Polyurethane paint	No comment
S-10	Effectively clean Nonhazardous Biodegradable Reusable Cost effective Quickly drying High flash point > 105 F Low toxicity	45 F	Acceptable if flash point and rust problems can be resolved	Paint and friction linings	No

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-11	Minimize hazardous waste Reusable or recyclable High flash point	- 50 F	Not acceptable due to the low freezing point	Grease, diesel fuel, Gasoline	No
S-12	Effectively clean Low VOC Low odor High flash point	- 65 C is sufficient	Acceptable if cleaner is strong enough to clean equipment and would not freeze	Paint and plastic/rubber materials	No
S-13	Effectively clean Ease of disposing safety to user	30 F	Acceptable if cleaner does not create corrosion problem	Lubricants	No
S-14	Effectively clean Good grease cutting Low odor Low toxicity	0 F	Acceptable if it has similar characteristics as P-D-680 and does not have a low temperature problem	Paint, rubber, O-ring	No comment
S-15	Ability to clean all parts	Ambient temperature	Not acceptable if it can not cut the petroleum based preservative	Paint, Rubber	No
S-16	Effectively clean Low odor Low flammability Low toxicity	Ambient temperature	Acceptable if it would clean like the P-D-680 without any rusting problem	Paints	Yes
S-17	No comment	No comment	No comment	No comment	Service contract
S-18	Strong solvent Safe to users Disposable Use Safety Klean solvents	No comment	Not acceptable due to the compatibility problem with lubricants	Lubricants	No

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-19	Clean well Water rinse Works quickly No residue Non-toxic No skin irritating High flash point (nonflammable)	20 F	Acceptable if it does not corrosion problems	Metals, rubber, teflon, plastic, paint	No
S-20	Effectively clean Safe to users, equipment, environment Quickly dry Recyclable High flash point	32 F	Not acceptable because it does not clean quickly or sufficiently for water resistant grease and causes corrosion	Paint, solid lubricants, rubber gaskets & seals and adhesives	No
S-21	Effectively clean Low toxicity	40 F	Not acceptable due to the more manhours to clean parts	None	No
S-22	Effectively clean Low odor Low toxicity	0 F	Not acceptable because of a high freezing point and a weak cleaning capability	Lubricants	Yes
S-23	Environmentally friendly product Ease of disposing High flash point	No comment	Not acceptable due to the rust and corrosion problem	No comment	No
S-24	Effectively clean for carbon and rust High flash point low toxicity	20 F	Acceptable if it does not freeze at - 40 F	Rubber seals, Plastic, sealing compound	No

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-25	Ability to remove variety of soils Safe for personnel and comply with environmental regulations Low odor High flash point > 200 F	- 65 C is satisfactory	Not acceptable because many water based cleaners must be rinsed off with water, and many parts can not be rinsed off with water due to rusting Water based cleaner specification exist (MIL-C-87937)	Same as MIL-C-87937	Yes
S-26	Jet Pressure Wash with hot water and detergent: Provide personnel protection Solve disposal problem Reduce procurement costs	No comment	Acceptable	No comment	No comment
S-27	Effectively remove oil, grease and carbon in ergonomic manner Environmentally friendly Cost Fast evaporation rate Little or no residue Recyclability No odor Low flammability	No comment	Acceptable if rusting does not occur	Lubricants	Yes (environmental view point) No (Off-the-shelf product could make P-D-680 more readily available for use)
S-28	Strong cleaning power Meet the emission constrains imposed by the Clean Air Act Amendments Leave no residue Safe to users Ease of disposing Low odor High flash point	Desert environment	Acceptable because it would be desirable due to the emission requirements	Chemical Agent Resistant Coating (CARC), paints	Yes

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-29	Effectively clean for grease and oil Environmentally safe Leave no residue Low odor Low toxicity	Maintenance temperature	Generally, water-based cleaner is easier to clean up and dispose of. If it can do the same job like P-D-680 solvents, it would be acceptable	Epoxy sealant, paints	No
S-30	High grease & film cutting properties Little or no health hazards Easily stored and low cost for disposal Low odor	Local usage temperature	Acceptable due to its easy usage, low health hazards and its easy disposal properties	Lubricants	No
S-31	Fast working degreaser Quick drying Low hazard	Room temperature	Not acceptable due to the strong odor and foam excessively	No comment	No comment
S-32	Rapidly clean Evaporate or air dry well Low odor Low toxicity	35 F	Acceptable	Paints, solid lubricants	No
S-33	Remove greases and oils Leave no residue High flash point	32 F	Acceptable if it works	It is used by itself	Either way
S-34	Quickly and effectively clean Low odor High flash point	50 F	Not acceptable because of its limited application	No comment	No
S-35	Remove oily grease quickly Low odor High flash point Low toxicity	32 F	Acceptable because it will be easily flush out of eyes and off other body parts	No comment	No
S-36	Clean grease Low toxicity	65 F	Acceptable because of EPA	No comment	No

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-37	Leave no residue Cut through grease and oil easily Low odor	No comment	Not acceptable due to the rusting problem	Solid lubricants	Yes
S-38	Quickly clean Nonflammable Low toxicity	65 F	Not acceptable due to the rusting problem	Paints	No
S-39	Keep P-D-680 solvents because it is one of the primary replacement for ODC solvents	No comment	No comment	No comment	No comment
S-40	Effective degreaser Safe to health Nonflammable Low odor	Do not use at -65 F	Not acceptable because caustic cleaners cause corrosion and are economically not acceptable	Paints, TT-E-489H	No
S-41	Non-hazardous to users Environmentally safe Ability clean a wide range of items No corrosion problem Easy to dispose of No special storage requirements Quickly clean Nonflammable Multipurpose solvent	Room temperature	Acceptable	Engine components	No
S-42	Clean with the least amount of effort and time Minimum hazard with best cleaning ability Biodegradable	72 F	Not acceptable	None	Yes
S-43	Use Simple Green and a hot water parts cleaner, plus a water soluble cleaner	No comment	Acceptable (currently use)	No comment	No comment

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-44	Same as P-D-680 Type II performance Recyclable	No comment	No comment	No comment	No comment
S-45	Fast, effective, and leave no residue or damage Remove grease and dirt without a great deal of scrubbing	Room temperature	Not acceptable unless it can be proven to no damage electronic components	Common electronic metals	No
S-46	Chlorine free High flash point >142 F None offensive odor Reasonable cost Leave no residue Minimal drying time No corrosion Low VOC Safe for skin exposure Recyclable	-5 F	Not acceptable A petroleum based solvent is preferable to make possible blending with waste oil for purpose of disposal	No comment	Either way (available in the federal supply system)
S-47	Effectively clean Leave no residue Safe to use Loosen carbon, gun powder residue and grease from metal parts High flash point	Do not use at -65 F	Not acceptable due to the corrosion possibilities	Solid lubricants	No
S-48	Safe for personnel and the environment Ease of disposing and its cost Quickly clean	Room temperature	Not acceptable	No comment	Yes
S-49	Nonflammable Leave no residue Effectively clean	No comment	Acceptable if it meets cleaning requirements	No comment	No comment

Table 3 (continued)

Code	Performance	Low Temperature	Water Based Cleaner	Material Compatibility	QPL
S-50	Ability to degrease and loosen sticky dirt High flash point > 125 F	Freezing point	Acceptable	CARC polyurethane paint, Rubber, Canvass, Rope and Stickers	No
S-51	Clean adequately Easy to handle/change out Leave no residue High flash point > 140 F	0 F	Not acceptable due to its poor performance	Solid lubricants	No
S-52	Effectively clean Easy and safe to users and environment Ease of disposing	32 F	Acceptable if it has the cleaning qualities of P-D-680	No comment	No
S-53	Ability cut carbon Leave no residue High flash point	- 20 F	Consider if it meets the current cleaning requirements	Paints, oils	Yes
S-54	Leave no residue Recyclable Ease of disposing Low odor	Room temperature	Acceptable	Paints	Yes

TABLE 4. TEST PROTOCOL FOR ALTERNATIVE P-D-680 SOLVENTS

Test	Method
Flash point	ASTM D 56
Distillation	ASTM D 86
Kauri-Butanol value	ASTM D 1133
Aniline point	ASTM D 611
Odor	ASTM D 1298
Non-volatile residue	TGA*
Evaporation @ °50 C, 20 min	TGA
Copper corrosion	ASTM D 130
Steel corrosion	Modified ASTM D 130
VOC content	EPA method 24
Relative solvency	Army soil test method

* Thermogravimetric Analysis

**TABLE 5. P-D-680 ALTERNATIVES
GENERAL INFORMATION**

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
Alkoscour 9620	Alko America 106 Elm Street Landcaster, SC 29720 1-800-424-9300	Self-Emulsifying Solvent: Methyl Ester Blend of Three Aliphatic Acids	Heavy Duty Cleaner, Degreaser; cutting oil, grease, and stain removal	none	T-1
Alkoscour 9622					T-2
Alkoscour 9624					T-3
Alkosurf 718					T-4
Arconate 1000 PC	Arco Chemical Co. 3801 West Chaster Pk Newton Square, PA 19073 610-359-2000	Blended Methyl Esters	part Cleaner	none	T-5
Arcosolv PTB		Dioxolanone: Propylene Carbonate; Cyclic Ester			T-6
Attar-C	Delta Omega	Aliphatic Glycol Ether: Propylene Glycol t-Butyl Ether, 1-(1, 1- Dimethylethoxy)-2-Propanol, 1-T- Butoxy-2-Propanol, PGTBE	Glass and Hard Surface Cleaner, Not Recommended for use in Acid-Base Aqueous Cleaners	none	T-7
Axarel 6100	Petrofirm, Inc. Specialty Chemicals 5400 First Coast Hwy Fernandina, FL 32304 904-261-828	Surfactant	Part cleaner	1:3	T-8
Bio Act 50		Hydrocarbon & Esters		none	T-9
Bio Act 280		Surfactant		1:10	T-10
		Aliphatic HC and Esters	Electronics and Parts Cleaner	none	T-10

Table 5 (continued)

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
BioCat- 145	Insitu Environmental Chemical Co 8402 E. Redwing Rd Scottsdale, AZ 85250-5740 602-948-9209	Alcohol and Water	Super Concentrate for Aqueous Degreasing, Bioremediation, or Cleaning; Non-Corrosive	1:20	T-11
BioCat-550		Emulsifier		1:20	T-12
dCat-15		Terpene and water		1:20	T-13
Breakthrough	Inland Technology Inc 2612 Pacific Hwy; E. Suite C; Tacoma, WA 98424 206-922-8932	Hydrotreated Heavy Naphtha, C ₁₂ - C ₁₃ Hydrocarbons	Removes Oils, Grease, Inks, Wax	none	T-14
Brulin MP 1793	Brulin Corporation	Isoparaffinic HC	Metal Cleaning	none	T-15
Brulin SD 1291		Dipropylene Glycol Methyl Ether		none	T-16
Brulin 815 QR		Emulsifier		1:10	T-17
Nature-sol 100		Dipropylene Glycol Methyl Ether, D'Limonene		none	T-18
Calla 301	Zip Chem/Calla Chemical 1860 Dobbin Drive San Jose, California 1-800-648-2661	Dipropylene Glycol Methyl Ester	Removes Oil, Grease, Carbon and Hydraulic Fluid	none	T-19
Calla 120		Terpene		none	T-20
Citrikleen HD	West Penetone Corp. 74 Hudson Ave Tenafly, NJ 07670 201-567-3000	Water, D-Limonene, Mono and Diethanamine	Cold Carbon Removal, Degreaser: Remove Carbon from Bearings and Pumps in Turbine Engines;	1:1	T-21
D-Greeze 500	Solvent Kleene, Inc 131 1/2 Lynnfield St Peabody, MA 01960 508-531-227	Hydrocarbon Compound	Cleaner and Degreaser	none	T-22

Table 5 (continued)

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
Daraclean 235,	W. R. Grace 55 Hayden Ave Lexington, MA 02173 404-691-8646 800-232-6100	Alkaline	Metal Cleaning and Electric Parts Cleaning	1:15	T-23
Daraclean 282					
Daraclean 291					
De-contam Tip	Electronic Space Products International 4050-venson way Ashland, Oregon 97520 1-800-638-2581	Organic Fatty Acid and Long Chain Alcohols	Degreaser: Removes Oils, Tars, and Fluxes	none	T-26
De-solv-it HD					
De-solv-it IF					
DOT 111/113	Delta-Omega Technologies, Inc. PO Box 81518 Lafayette, LA 70598-1518 318-237-5091	Proprietary "Surfactant System"; Biodegradable	Metal Cleaning; Precision Cleaner; Replacement for 1,1,1- Trichloroethane and CFC-113 Replacement for Solvents used in ASTM Standardization and Military Specification	1:1	T-29
Duopower	Chemsearch 214-438-0211	Aqueous, alkaline detergent	Shipboard Degreaser- Cleaning; Degreaser with Non-Persistent Emulsion	1:10	T-30

Table 5 (continued)

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
Voltz		Aliphatic + Natural Citron	Part cleaner	none	T-31
Electron Dielectric Solvent, Part # 0296	Ecolink, Division of Sentry Chemical Co. 1-800-886-8240	Highly Refined Aliphatic Hydrocarbons and Terpenes	Electric Solvent, Degreaser	none	T-32
Envirosolv 652	Fine Organic Corp 205 Main St. Lodi, NJ 07644-0687 1-800-526-7480	Non-Petroleum, Non-Chlorinated Solvent: D-Limonene, Proprietary Organic Solvent	Cleaner and Degreaser		T-33
Envirosolv 655		Proprietary Organic Solvent, Diethylene Glycol Monobutyl Ether, Monoethanolamine	Immersion Tank Cleaner, Removes Carbons, Greases, Oxidized Oils, and Difficult Industrial Deposits	none	T-34
Envirosolv CRX		D'Limonene, Diethyleneglycol Monobutyl Ether, Monoethanolamine	Removes grease, oil, and carbonaceous soil deposits	1:1	T-35
Exp. ABC II	Xcel Tech. Ltd 934 "D" Calle Negocio San Clemente Cal. 92673-6210 714-492-3559	Biodegradable Non-Emulsifying Aqueous Degreaser	Cleaning of bearings and/or highly complex assemblies	none	T-36
Exxsol D60	Exxon Chemical PO Box 5200 Baytown, TX 77522 713-425-2115	Hydrocarbon	General Parts Cleaning, Vapor Degreasing; Drawing Oil	none	T-37
Actrel 1171L					T-38
EZE 244	EZE Products, Inc PO Box 5744 Greenville, SC 29606 803-879-7100	Alkaline	Steel Parts; Dip Tank		T-39
EZE 662		Pet. Hydrocarbon		none	T-40

Table 5 (continued)

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
EZE 416L		methyl ether			T-41
Formula 724	West Penetone 201-567-3000	Catalytically Reformed Isoparaffinic Hydrocarbons	Low Vapor Pressure Cleaning Solvent	none	T-42
Gillite 0650	Man-Gill Chemical 3801 W. Chaster Pike Newtown Square, PA 19073 1-800-627-6422	Alkaline	Metal Cleaning	1:10	T-43
Magnusol 728		Emulsifier		1:4	T-44
Magnusol 798				none	T-45
Hurri Safe 9040	PCI of Virginia 1-301-320-9100	Alkaline, Contains 2-Butoxyethanol	Special Formula Degreaser: Cold Cutting Solvent, especially Parts Washing; Remove Light Oils and Production Fluids from Fe and Al Parts	1:1	T-46
Hurrisafe 9050				1:10	T-47
Hurrisafe 8015				1:3	T-48
Mean Green	SCS Marketing Group LTD; 11140 Rockville Pike; Rockville, MD 20852 1-800 0-886-5000	Alkaline, Glycol, Biodegradable	Heavy Duty Cleaner and Degreaser	1:1	T-49
Mirachem 100	Mirachem Corp: 2107 E. 5th St; Tempe, AZ 85281-3034 602-966-3030	Detergents, Emulsifiers, Stabilizers and C ₈ and C ₁₂ Hydrocarbons	Removes Oil and Grease	1:3	T-50
Mirachem 250				1:3	T-51
Mirachem 500				1:3	T-52

Table 5 (continued)

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
OCS H2002	OCS Manufacturing 429 Madera St; San Gabriel, CA 91776 818-458-2471	Alkaline, 2-Butoxyethanol	Removes Grease, Oil, Dirt and Carbon	1:10	T-53
OCS NFH2002				1:10	T-54
ECO-PRO 2020				none	T-55
OCS APC				none	T-56
OSD	Environmental Tech 1511 Kastner Place Sanford, Fla. 32771 1-407-321-7910	Aliphatic Ester	Metal Cleaning, Heavy Duty Cleaning and Degreaser; Replaces Chlorinated Solvents	none	T-57
RB Degreaser		Aqueous Based		1:10	T-58
RBD Semi		Aqueous Based		1:15	T-59
Penair HD-1	West Penetone Corp 74 Hudson Ave Tenafly, NJ 07670 201-507-3000	Terpene & water (solvent emulsion) MIL-C-87937B Type I	Removes oils and greases from aircraft exteriors	1:4	T-60
PF-145	P-T Technologies, Inc 208-4th Ave; S. Safety Harbor, FL 34695 1-800-441-7874	Non-Halogenated, Aromatic and Aliphatic Hydrocarbons	High Performance Degreaser Solvent	none	T-61
PF		Aliphatic Pet. HC and Terpene	Degreaser: NSNs have been assigned; Substitute for 1,1,1 Cable and Metal Cleaner	none	T-62
PF-WB		Hydrocarbons, Surfactant	Water-Based Heavy Duty Industrial Cleaner	1:1	T-63
PrimaClean 3600	Dow Chemicals 516-636-1340	Proprietary blend of paraffinic hydrocarbons and a P-series Alkyglycoether	General cleaner	none	T-64

Table 5 (continued)

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
Quaker 624 GD	Quaker Chemical Co Elm and Lee Streets Conshohocken, PA 19428 215-832-4000	Alkaline	Immersion Ultrasonic		T-65
Quaker 68-RAH					
Re-entry KNI 2000	Environmental Solvents 1840 Southside Blv Jacksonville, FL 32216 904-724-1990	Naphtha, hydrotreated heavy (1-methyl)-4-isopropenyl-1-cyclohexene	Part cleaner	none	T-66
KNI 1200		Terpenes with Additives	Tailored to meet cleaning needs; Remove Oils and Greases from Metal Parts and Electronic Assemblies	none	T-67
X-MPT Solvent		Proprietary Mixture of Isopropylbiphenyls		none	
Re-Entry VPS 2000		Terpenes with Additives		none	
Simple Green	Sunshine Makers Inc 15922 PCH Huntington Harbor, CA 92649 1-800-228-0709	Terpene: 2-Butoxyethanol	General cleaner	1:10	T-70
Skysol	Inland Technologies 2612 Pacific Hwy 206-922-8932	C12-C13 Paraffinic hydrocarbons and d-Limonene	Metal Clothing, All Purpose Cleaner: Remove Oil Residue and General Dirt	none	T-71
Skysol 100			General solvent cleaner for the aircraft industry		
Shell 142 Ht	Shell Chemical Co. 1-800-367-7658	Naphtha medium aliphatic (Hydrocarbon solvent)	Degreaser	none	T-72
				none	T-73
				none	T-74

Table 5 (continued)

Name	Manufacturer	Solvent Type	Use	Mixture Ratio (HC:Water)	Code
Lots of Instant Suds (LOIS)	US Polychemical Corp. Route 45; Spring Valley, NJ 10977 914-356-5530	Aqueous + Mixture of Citric Acid	Powerful Emulsifier Cleaner, Removes Heavy Buildups of Grease and Oil	1:15	T-75
Tarksol HTF 60	Terpene Technologies, Inc. 1325 Midtown Tower Rochester, New York 14604 716-423-0670	Terpene & alcohol Solvents	Paints and resin removal	pre-mix	T-76
Tarksol HTF 1050			Wipe solvent	pre-mix	T-77
Tarksol HTF 10			Dip aqueous solvent	pre-mix	T-78
134 Hi-Solv	Bio-Teck Inc. P. O. Box 20094, San Diego, CA 92120 619-280-8807	Complex blend of petroleum hydrocarbons	NSN: 6850-01-244-3207 odorless Part cleaner degreaser	none	T-79
Unocal 150	Unocal Pet. Products 800-967-7601	Hydrocarbons (Mineral Spirits)	Part cleaner	none	T-80
Ubix No. 0075	Enzymes Plus; DIV of Anderson Affiliates, Inc; 1451 Sugar Creek Blvd Sugar Land, TX 77478 713-242-7741 1-800-444-7741	Biodegradable Enzyme Based Cleaning Compound	Cleaning Military and Heavy Industrial Equipment of Common Soils, Heavy Oils, Greases and Dirt, Paint Chalk and Oxidation Products.	1:25	T-81
Ubix No. 0092			Qualification MIL-C-83873A; QPL No. SFTT-93-01 Premier Aircraft Precoating Surface Cleaning	1:7	T-82

TABLE 6. LABORATORY SOLVENT TEST RESULTS

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P.	D.P.							Cu	Fe	
P-D-680 (I)	47.0	165.4	204.6	39	0.1	61.2	strong	789.7	47.1	1a	no rust	94.7
P-D-680 (II)	63.0	182.8	206.7	32	0.07	73.1	strong	785.8	22.8	1a	no rust	94.4
P-D-680 (III)	93.3	223.4	269.0	31	0.3	76.1	odorless	823.2	4.6	1a	no rust	89.3
T-1	112.8	85.5	224.6	-	-	no	strong	none	9.3	3b	heavy rust	0
T-2	112.8	52.3	-	-	-	no	strong	none	50.8	3b	med. rust	15.2
		incapability										
T-3	112.8	79.3	-	-	-	no	strong	none	63.9	3b	heavy rust	52.1
T-4	112.8	124.2	224.5	54	-	no	mild	none	3.1	1b	no rust	84.3
		95.7	234.1	-	-	no	mild	1,200	1.9	3a	med rust	0
T-6	112.8	145.4	153.0	-	-	no	odorless	870	60.3	1a	no rust	89.9
T-7	none	98.6	101.2	-	-	no	mild	188/47	64.5	4c	no rust	68.3
T-8	61.1	separation baked										
		188.9	249.3	36	0.27	70.6	mild	820	19.1	1a	no rust	62

Table 6 (Continued)

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P	D.P							Cu	Fe	
T-9	none	84.7	167.7	37	-	no	mild	393/39	62.7	2c	med. rust	74.6
T-10	140.5	95.0	-	-	-	no	odorless	63	0	3b	no rust	66.1
		incapability										
T-11	none	51.2	100.6	-	-	no	odorless	none	63.2	4b	no rust	0
T-12	none	64.2	100.8	-	-	no	mild	none	59.9	4c	light rust	0
T-13	none	63.6	100.7	-	-	no	citrus	0.14/nil	80.0	2c	no rust	0
T-14	65.5	184.0	211.7	27	0.05	84.0	odorless	770	25.9	2c	no rust	87.6
T-15	61.1	185.6	212.0	28	0.09	85.9	mild	759.8	17.2	1b	no rust	84.8
T-16	71.1	127.0	200.2	>200	-	no	citrus	938	18.2	1b	no rust	86.1
T-17	none	60.0	104.8	-	-	no	citrus	89.6/8.1	76.6	2c	light rust	15.3
T-18	48.9	155.7	-	-	-	no	citrus	742	38.7	2c	no rust	91.8
		incapability										
T-19	93.3	81.8	101.7	-	-	no	low	56	66.3	4b	no rust	45.1
		sludge										
T-20	52.8	98.0	253.8	-	-	no	citrus	258	61.7	2c	no rust	2.3
		separation										
T-21	68.3	98.0	-	-	-	no	citrus	520/260	78.4	2c	med. rust	65.2
		incapability										
T-22	61	166.3	206.7	69	0.16	39.9	low	808	27.6	1a	no rust	90.1

Table 6 (Continued)

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P	D.P							Cu	Fe	
T-23	none	72.7	100.9	-	-	no	mild	60/3.75	59.4	1b	no rust	57.7
T-24	none	100.4	104.7	-	-	no	mild	60/5.44	70.7	2c	light rust	0
T-25	78.9	173.8	236.5	-	-	15.8	low	847	19.7	1b	no rust	87.8
T-26	none	100.1	101.0	-	-	no	bland	none	57.3	4b	light rust	16
		separation										
T-27	72.2	184.3	273.6	33	0.78	66.0	citrus	801	12.7	1b	no rust	85.4
		separation										
T-28	85.0	196.9	271.0	30	0.6	77.0	citrus	799	5.9	1a	no rust	77.5
		separation										
T-29	none	59.4	-	-	-	no	odorless	188/94	56.9	2c	light rust	10.6
T-30	none	61.3	100.6	-	-	no	low	none	68.6	2c	med. rust	88.8
T-31	61.0	185.7	254.4	32	0.45	73.9	citrus	239	12.3	1b	no rust	86.6
T-32	63.9	191.8	235.6	32	0.01	69.1	citrus	782	18.1	1b	no rust	87.8
T-33	64.4	189.7	219.3	35	0.2	45.3	citrus	778	15.7	1b	no rust	80.3
T-34	60.6	185.1	212.3	29	0.78	79.3	odorless	750	28.5	1a	no rust	85.1
T-35	51.6	68.5	-	-	-	no	citrus	522/261	58.7	2c	light rust	55.9
		incapability										
T-36	none	100.4	-	-	-	no	mild	nil	62.9	4c	no rust	59.2
		incapability										

Table 6 (Continued)

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P	D.P							Cu	Fe	
T-37	61.7	185.5	220.8	32	0.24	73.9	strong	784	23.9	1a	no rust	71.7
T-38	81.1	211.6	241.1	30	0.35	77.8	strong	797	10.1	1a	no rust	84.5
T-39	none	75.2	108.6	-	-	no	mild	176	73.4	4a	light rust	70.6
T-40	61.1	184.4	212.7	37	0.24	84.8	mild	768	25.1	1b	no rust	90.0
T-41	65	143.4	225.3	-	-	no	mild	885	23.7	1b	no rust	88.3
T-42	79.4	202.5	236.7	30	0.5	78.8	low	780	9.7	2c	no rust	92.4
T-43	none	43.3	100.7	-	-	no	mild	none	73.7	4c	light rust	75.9
T-44	62.8	separation		-	-	no	mild	none	76.9	4a	light rust	50.8
		68.1	103.3									
T-45	60	separation		-	-	no	strong	none	38.2	4a	no rust	83.6
		62.4	210.8									
T-46	none	separation		-	-	no	low	23/11.5	68.7	4a	med. rust	77.1
		99.5	100.4									
T-47	none	separation		-	-	no	low	23/2.09	66.8	4a	heavy rust	68.5
		99.7	100.8									
T-48	none	separation		-	-	no	low	23/5.75	69.9	2c	pitting	78.2
		99.7	100.3									
		incapability										

Table 6 (Continued)

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P	D.P							Cu	Fe	
T-49	none	99.8	101.7	-	-	no	mild	42/21	65.7	4c	med. rust	72.7
			incapacity									
T-50	none	82.2	100.4	-	-	no	mild	145/36	71.6	1b	no rust	46.5
			separation									
T-51	none	79.0	105.7	-	-	no	odorless	15/3.75	61.9	3b	heavy rust	0.
			sludge									
T-52	none	83.2	101.0	-	-	no	citrus	133/33	69.3	3a	no rust	29.5
			separation									
T-53	none	93.6	100.5	-	-	no	mild	206/19	70.9	4b	no rust	47.4
T-54	none	100.1	108.9	-	-	no	mild	206/19	66.1	4a	no rust	0
T-55	none	98.0	101.0	-	-	no	mild	163	84.9	4c	no rust	68.5
			separation /baked									
T-56	none	99.3	100.8	-	-	no	mild	50	70.3	4b	no rust	84.3
			separation /baked									
T-57	126.6	216.7	301.0	116	0.15	15.6	mild	none	6.4	1b	no rust	69.7
			separation									
T-58	none	56.8	101.4	-	-	no	odorless	none	67.3	2c	no rust	37.3

Table 6 (Continued)

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P	D.P							Cu	Fe	
T-59	none	68.7	100.7	-	-	no	mild	none	72.9	1b	med. rust	55.7
T-60	51.6	69.2	100.3	-	-	no	citrus	490/98	71.6	1b	no rust	71.9
		separation										
T-61	62.8	185.5	205.4	-	-	no	mild	800	25.9	1a	no rust	87.0
T-62	62.2	187.0	228.8	26	0.32	76.7	citrus	760	14.8	1b	no rust	92.3
T-63	93.3	78.5	101.4	-	-	no	low	460/230	75.0	4a	med. rust	54.9
T-64	103.9	90.9	267.3	71	0.38	58.3	mild	810	3.3	3b	no rust	88.4
T-65	none	83.2	111.9	-	-	no	low	none	64.4	4b	no rust	65.2
		separation										
T-66	63.3	188.1	212.7	29	0.42	83.4	citrus	767	27.3	1b	no rust	80.2
T-67	91.1	181.9	208.6	>125	-	no	mild	862	24.3	1b	no rust	92.8
T-68	62.2	182.3	234.1	65	0.39	49.3	mild	815	26.1	1b	no rust	89.0
		separation										
T-69	121.1	320.1	328.9	-	-	no	low	950	0	1b	no rust	49.1
T-70	91.1	191.3	210.2	>125	-	no	mild	1024	10.3	1a	no rust	78.6
T-71	none	98.1	104.3	-	-	no	low	7.96/nil	61.1	4a	heavy rust	69.0
T-72	66.7	189.4	212.4	29	0.16	83.0	citrus	770	20.0	1b	no rust	89.1
T-73	63.3	189.6	212.7	29	0.44	82.8	citrus	780	25.3	1a	no rust	88.6
T-74	62.8	191.0	211.9	32	0.18	73.3	mild	781	18.2	1a	no rust	91.3

Table 6 (Continued)

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P	D.P							Cu	Fe	
T-75	none	66.1	101.7	-	-	no	mild	none	74.1	4b	no rust	0
		forming /separation										
T-76	93.3	195.5	224.6	>500	-	no	pine	273	6.0	2c	med. rust	90.8
T-77	none	99.9	223.6	-	-	no	pine	none	61.9	3b	med. rust	82.3
T-78	none	100.2	224.2	-	-	no	lilac	383	39.2	2c	discoloration	56.1
T-79	97.8	232.4	299.3	24	0.07	94.5	odorless	796	3.8		no rust	80.7
T-80	66.7	186.0	212.7	31	0.15	71.2	mild	772	19.1	1b	no rust	90.2
T-81	none	35.8	100.2	-	-	no	mild	none	75.7	2c	heavy rust	87.0
T-82	none	68.0	100.6	-	-	no	mild	none	61.9	2c	light rust	0

APPENDIX



DEPARTMENT OF THE ARMY
UNITED STATES ARMY TANK-AUTOMOTIVE COMMAND
MOBILITY TECHNOLOGY CENTER - BELVOIR
10101 GRIDLEY ROAD, SUITE 104
FORT BELVOIR, VIRGINIA 22060-5818

REPLY TO
ATTENTION OF

AMSTA-RBF (70-1R(2))

13 June 1994

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Survey to Determine Requirements for an Ideal Replacement/Substitute to the P-D-680 Cleaning Solvent

1. As part of the Defense Logistic Agency's Hazardous Material Minimization Program, a non-hazardous replacement for P-D-680, Dry Cleaning and Degreasing Solvent, is being investigated. The work will be performed by the Fuels and Lubricants Division of TACOM's Mobility Technology Center-Belvoir.
2. U.S. Army and other Department of Defense (DoD) facilities are experiencing problems in using P-D-680 solvents for their general maintenance activities. This petroleum based solvent is considered a hazardous waste, causing difficulties with disposal. It is somewhat toxic, with a Threshold Limit Value (TLV) of 100 ppm. It contains small quantities of volatile organic contaminants (VOC), thus is regulated by local governments. However despite its limitations, it is extremely versatile, effective, inexpensive, and can be used for a wide variety of general maintenance operations. To best meet the current needs of the Army and DoD for a multipurpose cleaner, a survey is being conducted to determine what is viewed to be requirements for P-D-680 solvents, the positive and negative aspects of current cleaners, and the characteristics of an "ideal" cleaner replacement.
3. Request that this questionnaire be disseminated as widely as possible to P-D-680 users. This questionnaire should be returned no later than 31 July 1994 to:

US ARMY TANK-AUTOMOTIVE CMD
MOBILITY TECHNOLOGY CENTER - BELVOIR
ATTN AMSTA RBF (MR I RHEE)
5941 WILSON RD, STE 230
FORT BELVOIR, VA 22060-5843

AMSTA-RBF (70-1R(2))

SUBJECT: Survey to Determine Requirements for an Ideal Replacement/Substitute to the P-D-680 Cleaning Solvent

4. Questions may be directed to Mr. In-Sik Rhee at (703) 704-1824 or DSN 654-1824. We appreciate your cooperation in this matter.

Maurice E. Lepera

Encl

MAURICE E. LEPERA
Chief, Fuels and Lubricant Division
Mobility Technology Center - Belvoir

DISTRIBUTION LIST:

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AMSTA-RBF (70-1R(2)

SUBJECT: Survey to Determine Requirements for an Ideal Replacement/Substitute to the P-D-680 Cleaning Solvent

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CDR, DCMAO C O BARDEN CORP, (MR D GERAMITA), P.O. Box 2449, DANBURY
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HQ FORT MCCOY, ATTN AFZR DE E (MR S STOKKE), SPARTA WI 54656-5000

QUESTIONNAIRE FOR DEVELOPMENT OF A NON-HAZARDOUS P-D-680 CLEANING SOLVENT

1. USER CATEGORY

What is your class of materiel cleaned by P-D-680 solvents?
(e.g., weapons, artillery, armored, tactical vehicles, combat service support, etc...)

What type of facility (organization) do you represent?

Please provide your name, title, address and phone number:

2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or equipment? (e.g., types 1, 2, or 3)

What problems have you experienced with current P-D-680 solvents?

What do you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like or fit your applications?

Do you have knowledge of corrosion caused by current P-D-680 solvents? Please explain.

3. REQUIREMENTS OF THE IDEAL P-D-680 SOLVENT(S)

What is important in a cleaner?

What type of performance do you expect to the cleaner?

Do you need a solvent to be usable at -65°C ? If not, what is the lowest temperature at which the cleaner must be usable?

Do you think that a water based cleaner will be acceptable? Why?

Do you think that a water based cleaner will not be acceptable? Why?

What other products will be used with P-D-680 solvents to service or store the weapons, vehicles, and equipment? (i.e. lube oil, which one? preservative oil, which one? preservative paper? etc.)

What other materials must the P-D-680 cleaner be compatible with? (i.e. elastomers, paint, solid lubricants, etc?)

Are there logistical considerations that you must take into account in requesting P-D-680 solvents?

What type of containers/packaging are most useful for P-D-680 solvents?

Do you think that manufacturers of P-D-680 solvents should be pre-qualified to supply to the military, or that a commercial, off-the-shelf type product would be acceptable?

4. HEALTH, SAFETY OF WEAPONS CLEANER

Have you, or do you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of current P-D-680 solvents? Discuss.

Is the odor, or lack of odor, of the P-D-680 solvents, an important factor?

Do you have problems disposing of the P-D-680 solvents that you currently use?

Is the flammability of the P-D-680 solvents an important factor?
What are required?

Are you aware of the toxicity and safety of the P-D-680 solvents?
Is this important to you?

Is it reasonable to expect when cleaning to wear protective gloves
and to work in an open area when using P-D-680 solvents? Must the
cleaner be safe for use in confined spaces and for contact with
skin?

5. SPEAK OUT!

Please discuss anything else pertaining to P-D-680 solvents that
you would like to voice, especially comments and suggestions for
the development of an improved cleaning product?

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ACTIVITY
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2107 17TH STREET
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 - 1 142 MAS SQ/MAFAG (MR. KUTCHER)
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- 6801 NE CORNFOT AVE
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- PO BOX 2003
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